DOCUMENT RESUME

ED 040 259 UD 010 236

AUTHOR Rohwer, William D., Jr.; Levin, Joel R.
TITLE Elaboration Preferences and Differences in Learning Proficiency.
INSTITUTION California Univ., Berkeley. Inst. of Human Learning.; Wisconsin Univ., Madison. Research and Development Center for Cognitive Learning.
SPONS AGENCY National Inst. of Health, Bethesda, Md.
PUB DATE Mar 70
NOTE 39p.; Paper presented at the Annual Meeting of the American Educational Research Association, Minneapolis, Minn., March 1970

EDRS PRICE EDRS Price MF-$0.25 HC Not Available from EDRS.
DESCRIPTORS Academic Achievement, Academic Education, Age Differences, Cultural Factors, *Individual Differences, Intelligence Differences, *Intelligence Factors, Learning Difficulties, *Learning Processes, Learning Theories, *Paired Associate Learning, Socioeconomic Status, Teaching Procedures, *Thought Processes

ABSTRACT

The major emphasis of this study is on the comparative validities of paired-associate learning tests and IQ tests in predicting reading achievement. The study engages in a brief review of earlier research in order to examine the validity of two assumptions--that the construction and/or the use of a tactic that simplifies a learning task is one of the most critical prerequisites for successful performance, and that differences in elaborative facility and in preferences among particular kinds of elaborative tactics are responsbile for a major share of observed differences in learning proficiency. On the basis of these two assumptions, the study focuses on: (1) features of persons that can be established independent of the learning task on which performances are to be observed, such as sex, chronological age, IQ, and socioeconomic status-ethnicity; and (2) characteristics of learners that are endogenous to the task whereby learning proficiency is estimated, i.e. individual variables in particular learning tasks. The results evaluated are considered to indicate that a learning task might be a better predictor of long-term school learning than a test of the IQ variety. [Not available in hard copy due to marginal legibility of the original document.] (RJ)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

ED040259

ELABORATION PREFERENCES AND DIFFERENCES IN LEARNING PROFICIENCY[1]

William D. Rohwer, Jr.

University of California, Berkeley

Joel R. Levin

University of Wisconsin

Mental activities denoted by the term elaboration may be viewed as ways of thinking while learning. When they are effective, they demonstrate how thinking can improve learning. Shortly, elaboration will be defined specifically and concretely in connection with particular learning tasks. For the moment, however, it is appropriate to begin with two explicit assumptions: (a) the accomplishment most crucial for efficient performance on a learning task is that of selecting or concocting a tactic that renders the task easy; and (b) some of the major sources of difference in learning proficiency between persons is their facility in using and, if necessary, producing effective learning tactics, and in their preferences for some kinds of tactics rather than others.

UD010236

A substantial class of learning tactics is elaborative in character, that is, the tactics involve enriching or augmenting the elements to be learned beyond their minimal form. In the case of noun-pair learning, elaborative tactics include the following examples: inserting each noun pair in a sentence context; representing the noun pairs as their object referents; envisioning brief episodes involving the two object referents of each pair. In each of these examples, the minimal elements, aurally presented noun pairs, are elaborated by the addition of other elements.

AERA Paper, 1970

Speculatively, these other elements may be thought to have their effect through extending or augmenting the meaning of the original materials.

Several strands of evidence suggest that elaboration of the kind illustrated by the preceding examples is produced by subjects who perform effectively on certain learning tasks and that such elaboration increases the efficiency of learning. Post-learning interviews of college students (Runquist & Farley, 1964; Martin, 1967;Montague, Adams & Kiess, 1966; Montague & Wearing, 1967) and of school age children (Martin, 1967) yield reports of elaborative activities during learning. Instructions to generate sentences (Jensen & Rohwer, 1965) for noun pairs and to envision interactions involving noun-pair referents (Bower, 1969) produce increments in learning efficiency. Similarly, the presentation of learning materials in elaborated form facilitates learning. Evidence for the positive effect of presented elaboration has been reported in the case of sentence contexts for noun-pair learning (Rohwer, 1967), narrative story contexts for learning serial lists of noun pairs (Levin & Rohwer, 1968), and for the pictorial representation of the object referents of noun pairs in either meaningful spatial relationships (Davidson & Adams, 1969) or in animated interaction episodes (Rohwer, Lynch, Suzuki & Levin, 1967). Thus there is substantial empirical support for the conclusion that subjects do elaborate learning materials and that whether the elaboration is self-generated or experimenter-provided, it improves learning efficiency.

Because the focus of the present discussion is on individual and group differences, it is important to emphasize the distinction between the production and the use of elaboration. It is easy to conceive the possibility that individuals or groups may differ with respect to one of these functions, for example, in their ability to produce effective

elaboration, and not in the other, that is in their ability to use elaboration when provided. Accordingly, this distinction should be kept in mind throughout the remainder of the essay.

A noteworthy characteristic of elaborative phenomena is that under optimal conditions, the amount of facilitation observed is extraordinarily large. Jensen and Rohwer (1965) reported that sixth-grade children instructed to name each of the two objects in a list of paired pictures did not achieve mastery of the list, on the average, until the ninth trial; in contrast, all children instructed to construct a sentence containing the names of the two objects in each pair performed perfectly by the second trial. Similarly, when pictorial paired-associates (PAs) were presented to second-grade children as separated, independent objects, the mean number of correct responses was less than 6 but when the same objects were depicted as joined together spatially, the mean was more than 29 out of a maximum score of 40 (Davidson & Adams, 1969). Thus, this brief review leads to the conclusion that the starting assumption is probably valid: the construction and/or the use of a tactic that simplifies a learning task is one of the most critical prerequisites for successful performance.

The fact that elaboration can be effective in learning is, of course, far from a complete story; not all ways of elaborating or augmenting learning materials are effective; some even retard performance. Indeed, one of the most salient characteristics of elaboration is that it is effective only under relatively restrictive conditions. In support of this assertion, consider the results of the following selected experiments in which the method of investigation has been that of PA learning.

When noun pairs are presented to sixth-grade children without elaboration (e.g., COW BALL) they are learned more easily than when presented in the context of a series of consonants (e.g., f s COW d w g BALL); the presentation of the nouns in a sentence, however, produces more efficient learning than either of these (e.g., The running COW chases the bouncing BALL). One kind of phrase context (e.g., The running COW behind the bouncing BALL) makes learning nearly as easy as does a sentence context but another kind of phrase context (e.g., The running COW and the bouncing BALL) produces performance no better than that when the nouns are presented alone (Rohwer, 1966). Even the use of a sentence context does not guarantee that elaboration will be effective. Some kinds of sentences are successful, "He followed the DOG and the CART," while others are not, "He and the DOG followed the CART" (Suzuki & Rohwer, 1969); meaningful sentences like, "ROSES drink RAIN" work while anomalous sentences like, "ROSES drink HATS" do not (Rohwer & Levin, 1968). Instructions to visualize separately the referents of each noun in a pair produce no facilitation whereas instructions to visualize the referents in an interacting scene improve performance (Bower, 1969). The amount of facilitation produced by elaboration conditions also varies as a function of other task variables such as pacing rate (Rohwer & Ammon, 1968), whether responses are made by recalling or by recognizing missing pair members (Kee & Rohwer, 1970; Rohwer & Lynch, 1966), and the kind of test cue provided (Ehri & Rohwer, 1969). In these and a number of other ways, the magnitude of elaboration effects varies as a function of a variety of very specific learning conditions.

Strictly speaking the present state of relevant research imposes rather narrow boundary conditions on the validity of the assumption that elaboration is critical for efficient learning. The assumption is most

compelling in the case of paired-associate learning, almost equally so in free recall, a little less so in serial learning. The probable validity of the assumption beyond these tasks depends upon the tenets of the theoretical position to which the issue is referred; in some quarters, the assumption is so obviously valid as to be trivial across a broad spectrum of tasks, including virtually all of those involved in school learning; in other quarters it is highly suspect outside the boundaries of the evidence reviewed here.

Besides the limitations imposed by task variables, the effects of elaboration may also be related to another class of variables: characteristics of the learner. Two questions are raised by this possibility: Are there reliable differences between distinguishable classes of learners in the efficiency of their performance on learning tasks; and, Can a significant portion of such between groups variance be accounted for in terms of differences in the production and/or use of elaborative learning tactics? A consideration of these questions obviously entails an evaluation of the second of the two major aysumptions with which this essay began, namely that differences in elaborative facility and in preferences among particular kinds of elaborative tactics are responsible for a major share of observed differences in learning proficiency.

First, however, two definitional matters deserve clarification. One concerns the relationship between the terms <u>efficiency</u> and <u>proficiency</u> in learning. As used here, both terms refer to one or a collection of indexes that roughly reflect the ratio of performance level to amount of time invested in learning. Efficiency is used to refer to cases where the ratio varies as a function of learning conditions; proficiency to cases where the ratio varies as a function of differences between subjects exposed to

identical sets of learning conditions. Thus, proficiency implies a relatively enduring characteristic of persons with respect to the ratio. In order to investigate the possible relationships between elaboration and learning proficiency, however, it must be established whether or not individual differences in performance are reliable across tasks. The reliability of such differences needs to be ascertained both across parallel forms of the same task and across different tasks as well. If consistency can be established, then it is possible to test the hypothesis advanced here: that differences in learning proficiency are attributable to differences in the production and/or use of elaborative tactics. Notice that two different research methods are required for evaluating the production and use aspects of the hypothesis: with respect to production, the method of instructed or self-generated elaboration is indicated whereas the method of presented elaboration is appropriate for the question of differences in the effective use of elaboration.

The second definitional matter concerns the use of the term individual differences. In its most fully developed form, the notion of individual differences is a very sophisticated one. Here, however, it is used in a relatively simple sense. It refers to the grouping together of individuals who share a greater similarity among themselves on some feature or set of features than they do with another collection of individuals. Two kinds of bases for such grouping will be considered: (a) in terms of features or variables exogenous to the performances to be observed; and (b) in terms of features or variables endogenous to the performances to be observed. The distinction rests on the issue whether subjects are classified by means of a set of operations that are different from or the same as those that generate the dependent measures.

Exogenous Features and Differences in Learning Proficiency

To be considered in this section are features of persons that can be established independent of the learning task on which performances are to be observed. Among such features are sex, chronological age, IQ, and socioeconomic status (SES) - ethnicity. The latter feature, of course, represents a confounding of two collections of variables; this confounding is intentional since the two variables are so highly correlated in naturally-occurring populations and since most of the studies to be examined have thus confounded them. Such confounding is generally to be avoided and especially so if such variables are those to be used in accounting for observed variance. In the present discussion these variables do not occupy such a role. Here it is elaboration variables that will be examined for their sufficiency in accounting for variance in learning proficiency.

Chronological Age and the Elaboration Hypothesis

There is ample evidence that performance on paired-associate learning tasks varies as a function of chronological age. Jensen and Rohwer (1965), for example, administered a 10-item list of pictures of paired objects to samples of kindergarten, first-, third-, sixth-, eighth-, tenth-, and twelfth-grade subjects. The mean number of trials to criterion for the two extreme age groups were 12 and 2 for kindergarten and twelfth-grade Ss respectively. Similarly, Rohwer, Lynch, Levin, & Suzuki (1968) administered a 24-item pictorial PA list to kindergarten, first-, third-, and sixth-grade children and found that grade level differences accounted for a substantial portion of the variance between Ss.

With reference to such age-related changes in learning efficiency, the question of present interest is the extent to which they can be attributed to parallel changes in the production and use of elaborative learning tactics. From the results of their study, Jensen and Rohwer (1965) concluded that a major reason for the improvement in performance as a function of grade level might have been a correlated increase in self-activated elaborative activity. This inference was drawn from comparisons of sentence elaboration and control conditions at the successive grade levels. Performance in conditions where sentence instructions were given was markedly superior in the first-, third-, and sixth-grade samples but in the older samples, learning in the control conditions was virtually as efficient as that in the sentence instruction condition.. Accordingly, it was argued that with increasing age, subjects engage in self-activated elaborative activity that is functionally equivalent to that elicited by instructions to elaborate by means of generating sentences. Although this interpretation is a plausible one, the data from which it arose are problematical in some important respects: study trial time was not equated for sentence and control conditions; a severe ceiling effect may have reduced the possibility of detecting differences between sentence and control conditions in the sixth-, eighth-, tenth-, and twelfth-grade samples; and, finally, the design did not include a condition in which self-activated elaboration was prevented or at least discouraged. This latter condition is necessary to provide an adequate test since the elaboration hypothesis asserts that subjects produce and use such learning tactics whenever conditions permit.

A study recently completed by Joan Bean was designed to eliminate these sources of uncertainty in evaluating the hypothesis that self-activated

elaboration increases with age. A thirty-item list of noun pairs was presented aurally by a study-test method to samples of first-, third-, sixth-, eighth-, and eleventh-grade subjects. At each grade level, the pairs were presented in four different ways: Control, in which ordinary PA learning instructions were given and the noun pairs were presented without elaboration; Rehearsal, in which subjects were instructed to repeat each noun pair aloud until the onset of the next pair; Sentence Context, where each noun pair was presented in the context of a sentence; and, Generated Sentence, in which subjects were instructed to construct and utter a sentence containing the nouns in each pair. Performance was indexed in terms of the mean number of correct responses (maximum = 30) given on the first test trial.

The results are displayed in Figure 1 as a function of Grades and Conditions. These data have several interesting features. First note that

- - - - - - - - - - - - - - -

Insert Figure 1 about here.

- - - - - - - - - - - - - - -

the degree of learning efficiency produced by the two sentence conditions does not differ significantly at any grade level; self-generated sentences have no advantage over experimenter-provided sentences. Second, note that in the first-, third-, and sixth-grade samples, the Researsal and Control conditions do not differ significantly. In the eighth-grade sample, however, performance in the Control condition is superior to that in the Rehearsal condition and in the eleventh grade the difference favoring the Control condition is even larger. Our interpretation of this aspect of the results is that self-activated elaboration begins to typify the learning

process in children between the sixth- and eighth-grade levels and that the kind of rehearsal required, that is, simple repetition of the pairs, interferes with these activities. Whatever the character of the self-activated elaboration, in the eighth-grade sample it is not as efficient as either presented or instructed sentence elaboration. In the eleventh-grade sample, the control condition is superior to all others, suggesting that self-activated elaboration may be of a different character than self-generated sentences (e.g., imagery processes like those posited by Bower, 1969). Indeed, a comparison of the eighth- and eleventh-grade results in the sentence conditions indicates that for the older Ss sentences retard rather than facilitate learning.

Additional examination of these results lends support to what has already been suggested, namely that the emergence of self-activated elaboration may account for a major share of the variance between age groups. For third- and sixth-grade children, sentence conditions are associated with a degree of learning efficiency equivalent to that displayed by subjects as old as eighth graders in the control condition. The inferior performance of the first-grade sample suggests that these children cannot yet make maximal use of sentence elaboration even when it is provided.

IQ and the Elaboration Hypothesis

To be considered next are two methods for evaluating the elaboration hypothesis as it applies to variance in learning proficiency that is associated with IQ. The first is the method of normal-retardate comparisons and the second is the method of elaboration-control contrasts with respect to correlations between IQ and PA learning efficiency.

A number of studies have been reported in which significant differences have emerged between normals and retardates when compared in terms of

performance on PA learning tasks (for reviews, see Zeaman & House, 1967; Jensen, 1969a). The question of interest is whether or not such differences are attributable to corresponding differences in self-activated elaborative tactics.

The question has received an affirmative answer from Martin (1967) in his interpretation of results obtained in a study comparing normal and educably retarded children. All Ss were administered an 8-item PA list. The normal group ($\overline{CA}$ = 11-7) was treated as a control condition as was half of the retarded sample ($\overline{CA}$ for the entire retarded sample = 11-9). For the other half of the retarded sample, the PAs were presented in an elaborated verbal context. Performance in the normal-control group was significantly superior to that in the retarded control. The performance of retarded children provided with elaborated contexts, however, was significantly superior to that of retarded-control children and indistinguishable from that of the normal controls. Accordingly, the investigator concluded that the usual superiority of normal children in PA learning is attributable to their propensity for engaging in self-activated elaboration of the materials to be learned.

Rohwer and Lynch (1968) have reported similar results in a study comparing third-grade children of normal IQ with retarded adults matched with the third-grade sample in terms of mean mental age. That is to say, when the PAs were presented under elaboration conditions, the performance of the retarded samples was not significantly inferior to that of the normal sample in the control condition. The interpretation of this result is complicated by the fact that when both samples were compared under elaboration conditions, the superiority of the normal groups was as large

as under control conditions. These results are entirely consistent with those reported by Jensen (1965) for a similar study with fourth-grade normals and $\overline{MA}$-matched retardates. Thus, the outcome of these few studies bearing on the hypothesis that differences in elaborative activity can account for IQ-related differences in learning proficiency provide mild but qualified support.

Even fewer data relevant to the hypothesis have been produced by the second method of investigation, that is, correlational method. Although it is not at all conclusive, one study will be described by way of illustration (Rohwer, Ammon, Suzuki & Levin, in press). Since the study will be referred to again in a subsequent section, it is worth detailing rather completely. The sample consisted of 288 children drawn in equal numbers from kindergarten, first-, and third-grade classes of schools serving high-SES White population and from schools serving a low-SES Black population. Each child was administered the Peabody Picture Vocabulary Test (PPVT), the Colored Progressive Matrices (CPM) and four, 25-item PA lists. Each PA list was composed of five different types of items distinguished by the manner in which the pairs were presented: Nouns--aural presentation of noun pairs; Pictures--visual presentation of pictures of paired objects; Nouns-Pictures--pictures of paired objects with their noun labels presented aurally; Sentences-Pictures--pictures of paired objects with the aural presentation of sentences containing the noun labels of the objects; Nouns-Action--pictures depicting action episodes involving the two objects in each pair with the appropriate noun labels presented aurally. The capability necessary for presenting the action episodes was provided by recording all materials on videotape for playback through a television monitor.

Given a study of this design, the prediction implied by the elaboration hypothesis is that the correlations between IQ and learning efficiency should be smaller in the case of elaborated than in the case of unelaborated Item Types. To assess these predictions, consider the correlation coefficients between the PPVT and the PA tests for the high-SES White samples. These coefficients are displayed in Table 1. An inspection of these results

- - - - - - - - - - - - - -

Insert Table 1 about here.

- - - - - - - - - - - - - -

yields no support for the elaboration hypothesis. Indeed, if these coefficients lend support to any conclusion it is that the elaboration hypothesis is wrong with respect to IQ related differences in learning proficiency. The magnitude of the correlations between these two variables is generally greater for elaborated Item Types (Sentences-Pictures and Nouns-Action than for the Item Types that are less elaborated, although this result may be an artifact of the mixed-list design employed.

Thus, the two methods of investigation yield contradictory conclusions; the first lends support to the elaboration hypothesis while the second tends to negate it. Clearly the available data are not sufficient to compel a firm conclusion. In an effort to resolve the issue of IQ-related differences in learning proficiency, it might be useful to apply the research design used by Bean to assess the elaboration hypothesis in the case of age-related differences.

Ethnicity-SES and the Elaboration Hypothesis

The research designs that might profitably be used to assess the validity of the elaboration hypothesis in accounting for populations-related

differences in learning proficiency include all of those discussed thus far. Unfortunately, they have not all been applied to the problem as yet. For example, a particularly useful method might be that of contrasting PA learning proficiency under Control, Rehearsal, Sentence Context, and Generated Sentence conditions among two or more populations. As described in a preceding section, this design has already been applied to high-SES White samples of first-, third-, sixth-, eighth-, and eleventh-grade subjects; it has been applied as well to low-SES White samples from the same grade levels (Bean & Rohwer, 1970). Currently the design is being replicated with low-SES Black samples of sixth-, eighth-, and eleventh-grade subjects. Simply stated, the comparative outcome for the low-SES Whites is that none of the interactions displayed for the high-SES Whites in Figure 1 hold true. Even in the eleventh-grade sample, the Control condition is associated with the lowest level of performance and both of the sentence conditions produce more efficient learning than either the Control or the Rehearsal condition. Accordingly these results support the suggestion that differences in self-activated elaborative activity may indeed account for an overall difference in learning proficiency, at least for these two populations.

In contrast with this conclusion, consider the results of studies using a simpler research design and the populations of high-SES White and low-SES Black children. In most of the work reporting comparisons between these two populations in terms of performance on PA tasks, very little variance has been found to be associated with the populations variable (Semler & Iscoe, 1963; Rohwer, 1967; Rohwer, Lynch, Levin & Suzuki, 1968; Rohwer, Ammon, Suzuki & Levin, in press) especially for children above the

level of first grade. When population-related differences do emerge, they appear to be stronger in elaborated than in non-elaborated conditions. This result, of course, runs directly counter to the elaboration hypothesis. Accordingly, the question is still unanswered.

A related issue remains equally undecided: despite the equivalence of these two populations in terms of performance on PA tasks and even on free recall tasks where the materials consist of non-categorized items, markedly large amounts of populations variance are found on IQ tasks such as the PPVT, the CPM, and the WISC. Attempts to rationalize this discrepancy have been made (cg., Jensen, 1969a;Rohwer, in press) but they are far from being entirely satisfactory.

Endogenous Features and Differences in Learning Proficiency

In the examples reviewed, it has been possible to show that elaboration variables can modify, sometimes substantially, the relationship between various exogenous characteristics of persons and their learning proficiency. In this final section, a similar demonstration will be attempted for characteristics of learners that are endogenous to the task whereby learning proficiency is estimated.

As defined here, exogenous characteristics of learners typically can be traced to <u>group</u> (frequently status or demographic) variables; that is, generally agreed upon classification systems which are independent of the particular learning tasks being investigated. On the other hand, endogenous characteristics may be thought of as <u>individual</u> variables in particular learning tasks; that is, unique personological variation which may be extracted only upon an examination of the individual learners.

It is a patent assertion in the behavioral sciences that performance variability attributable to subjects' endogenous characteristics is overwhelming, even under conditions where exogenous variables are controlled to some extent, for example, by sampling from homogeneous groups. Moreover, the stability of individual difference variation may be assessed on the basis of test-retest or parallel form (usually separated in time) reliability estimates of the measuring instrument of interest. In this regard, reported coefficients of stability for standardized achievement and aptitude tests pervade the psychological literature and in many cases, different reliability estimates of the same test are provided for different norming groups (exogeneous characteristics of the subjects being considered).

The same kind of information may be gleaned from tasks which purport to measure "learning ability," in contrast to the "learned abilities" that are reflected by most tests of intelligence. Unfortunately, reliability estimates of learning tasks do not often appear in published form. This, of course, may be explained by the fact that most learning studies incorporate instruments which are experimenter-made rather than standardized. In addition, the instruments often are of an "ad hoc" variety: they are employed in a relatively short duration experiment or set of experiments, and are never called upon again. Clearly there is a need to develop learning task batteries which demonstrate reliabilities comparable to those of available psychological tests, but at the same time validities appropriate to the underlying cognitive variables being measured. The remaining sections will focus on these questions in the context of certain learning tasks already discussed.

The Stability of PA Learning Proficiency

Reconsider the experiment previously described, in which 288 children sampled equally from kindergarten, first, and third grades in both high-SES White and low-SES Black populations were tested (Rohwer et al., in press). It will be recalled that four 25-item PA lists were administered to the children: two (along with the PPVT) during one testing period, and two following an interval of two days. Thus, by determining each child's initial PA learning ability (on the basis of his performance on the first two lists, or Form A of the test) as well as his subsequent performance (the second two lists, or Form B), equivalence-stability reliability estimates of the task could be obtained.

The reliability coefficients for each of the six samples are presented in Table 2, which is highlighted by two features. In the first place, although

- - - - - - - - - - - - - -

Insert Table 2 about here.

- - - - - - - - - - - - - -

the size of the coefficients does not rival, let us say, those of popular standardized IQ instruments reported in test manuals, they are of sufficient magnitude (.54 to .87) to merit regard. Secondly, it appears that the estimates vary as a function of the exogenous characteristics of each sample (in this case, age and SES-race). This is further substantiated by a statistical test for the equality of these coefficients across populations (Hays, 1963; Marascuilo, 1966), which is rejected with the probability of a Type I error (α) equal to .05. An interpretation of this finding is not immediately forthcoming, however, as no systematic trends are apparent. What is important to note is that endogenous variables may be

interesting in their own right, as well as in comparison or in interaction with exogenous variables. Illustrations of this point will be provided shortly.

An alternative way in which the stability of PA learning proficiency may be investigated is to block subjects on the basis of Form A performance, and to observe the effect of this blocking on the reduction of within group variance in Form B performance. When this is done for the present task, a substantial portion of variance associated with blocks (i.e., initial learning ability) is detected. Moreover, for each of the three age-grade populations, the amount of variation in Form B performance attributable to Form A performance greatly exceeds that attributable to the SES-race variable. Thus, ignoring endogenous characteristics in the face of exogenous ones may have the serious effect of producing gross misclassifications of individual proficiencies. Jensen (1969a) addresses himself to this issue.

How permanent or durable are PA learning abilities? The data just reviewed were based on a two-day time lapse between the two forms of the test. Two other studies from our laboratories have examined children's performance of PA tasks after 5-10 days (Ammon & Rohwer, 1969) and after 14-30 days. In both cases, second list differences associated with initial list learning ability parallel what has already been reported. Further long-term investigations of the learning ability variable are indicated for both PA and other types of learning paradigms.

One thing more should be mentioned in this regard. Preliminary analysis of data from the three previously mentioned experiments involving almost 400 children (preschoolers through third graders) suggests that learning ability may well interact with the variable of SES-ethnicity. As has been noted, the latter variable is found to be associated with

small (but in some studies, statistically significant) differences in PA performance. However, when the children are blocked in terms of initial list learning, differences in second list performance between the higher ability children of the two SES-race populations are on the average negligible when compared with differences between the lower ability children from the same populations. That is, it might be possible to explain the slight PA learning differences between high-SES Whites and low-SES Blacks in terms of the relatively inferior performance of poor learners from the latter population to that of poor learners from the former. This is but one example of a potentially interesting interaction of endogenous and exogenous learner characteristics which warrants study and explanation.

Individual Differences and Elaboration Preferences

It goes without saying that educators are interested in determining which individuals are likely to succeed easily in school and which ones are not. This may involve a separating out of the good from the poor (or the faster from the slower) learners on the basis of certain criteria. What seems to be given lighter regard is the hypothesis that the vast majority of students may succeed easily if they are given optimal instruction and/or conditions of learning (Carroll, 1963). In this domain may be found the recent discussions of aptitude by treatment (ATI) interactions (Bracht, 1969; Cronbach, 1967; Cronbach & Snow, 1969; Jensen, 1967; Walberg, 1970); that is to say, the notion that certain instructional methods and materials will be most effective for some students whereas different methods and materials will be most effective for others.

In the context of the present PA learning experiments, at least one aspect of the ATI hypothesis is subject to validation. The task incorporated by Rohwer et al. (in press) consisted of materials presented to learners as five different types of auditory and visual combinations. The various item types have been described in a previous section, where it was indicated that reliable differences among the item types were detected. Thus, some methods of presenting materials produced more efficient learning than others.

However, an additional question may be phrased in terms of ATI, or the propensity of certain children to "prefer" particular kinds of elaboration materials: namely, are there reliable individual perferences such that some children benefit more from items defined by one aural-visual combination, while other children benefit more from those defined by another? Note that "preferences" as used here, refer not only to the kinds of strategies spontaneously employed by learners, but also to the kinds of stimulus materials which may suit these strategies.

An answer to this question is obtainable from the present study since: (a) a mixed PA list was employed, whereby every child was administered each of the five item types and what is more, they were administered concurrently (i.e., differences in time, practice, retroactive and proactive effects were balanced across item types); and (b) a second form of the test was administered on another occasion to assess the stability of individual preferences for particular item types.

With the five item-type scores on two occasions as dependent variables, an analysis-of-variance comparison of the variation associated with Subjects

by Item Types and that of Subjects by Item Types by Occasions (Winer, 1962) suggested that reliable subject preferences for particular item types did exist. Within the six age and SES-race samples, a multivariate correlational analysis was performed to determine whether each population exhibited a relationship between the five item types on Form A and those on Form B. All of the multivariate tests yielded a significant F-value with $\alpha = .05$, indicating an association between the two sets of variables in each of the populations.

Following this, a canonical analysis was conducted in order to discover those linear combinations of Form A item types and those of Form B which were maximally correlated (Hotelling, 1936). Nine significant ($\alpha = .05$) canonical correlations were detected: one in each of the high-SES White and two in each of the low-SES Black populations. These are presented in Table 3. The largest canonical correlations (I) in each sample should be

- - - - - - - - - - - - - -

Insert Table 3 about here.

- - - - - - - - - - - - - -

compared with the values reported in Table 2, which are based on <u>total</u> test scores. It will be noted that the two sets of coefficients compare quite favorably, such that the canonical correlations of Table 3 are only a little larger than the Table 2 correlations.

The first significant canonical correlation might be thought of as a measure of general PA learning ability, which is closely approximated by the simple correlation between the two forms of the test. The canonical weights for the two sets of variables were found to be in the same direction

and of generally comparable magnitudes, thus producing weighted composites quite similar to scores simply based on the sum of all item types for each form of the test.

The second significant canonical correlation (II), obtained in each of the low-SES Black populations, may be best interpreted upon an examination of the canonical weights on Forms A and B of the test; as well as upon inspection of the canonical structure, or the correlation between each canonical variate (weighted composite) and the original variables of the appropriate set. [See, for example, Meridith (1964) and Porebski (1966) for an application of these techniques.] The canonical structures of the significant canonical variates are presented in Table 4, where it may be

- - - - - - - - - - - - - -

Insert Table 4 about here.

- - - - - - - - - - - - - -

seen that the direction and magnitude of the correlations between Canonical Variate II and the Form A item types are roughly paralleled by the corresponding correlations for Form B.

Furthermore, the correlational pattern found among low-SES Black kindergarteners is more or less replicated in the first- and third-grade samples. In each case, the correlation between the P item types (where PAs were pictorially presented <u>without</u> accompanying verbal identification or elaboration) and the canonical variates is opposite in sign to most of the others. In particular, the correlations for P item types and those for N item types (where PAs were simply labeled <u>without</u> accompanying pictorial support) provide an interesting contrast insofar as their respective canonical structures are concerned.

A verbal-pictorial "factor" may be posited to account for such results, especially in light of what is known about the relationship between language and learning. A more detailed description of individual preferences for verbal or pictorial materials may be found elsewhere (Levin & Rohwer, in press). Suffice it to say that: (i) the presence of a second significant canonical correlation indicates that the amount of information conveyed by the data (consisting of several item type scores) is in excess of the reliability findings based on total test performance on two occasions; and (ii) the replicated second canonical variates and their associated structures in each of the low-SES Black samples (but in none of the high-SES White samples) lends further credence to the reality of interactions between exogenous and endogenous learner characteristics.

PA Proficiency as Related to School Learning

Until now, we have focussed on reliability aspects of PA tasks which have been employed among children of various ages and from differing socioeconomic backgrounds. It has been noted that the instrument used: (a) is fairly consistent with respect to characterizing PA learning ability; and (b) may provide useful information with respect to classifying learners according to their elaboration preferences. In this final section, attention will be paid to empirically gathered validity data regarding the utility of PA tasks.

It is frequently reported that the correlation between IQ and scholastic achievement falls in the range .5 to .7, although the size of this relationship is difficult to document through carefully controlled experimentation. Recent studies looking at the relationship between certain process learning (e.g., PA performance) and school learning (e.g., reading

achievement) measures have exhibited correlations of comparable magnitudes (e.g., Anderson & Samuels, 1970; Giebink & Goodsell, 1968; Otto, 1961; Stevenson et al., 1968). Complicating the issue is the finding that the relationship between IQ and process learning is not at all clear, though it is currently being investigated (Glasman, 1968; Green, 1969; Humphreys & Dachler, 1969; Jensen, 1969 ab; Jensen & Rohwer, 1968; Rohwer et al., in press; Rohwer & Lynch, 1968; Semler & Iscoe, 1963). It is safe to say that the size of the latter correlation appears to vary with the IQ tests, learning tasks, and exogenous or group characteristics of subjects employed.

In most cases, the interrelationships between IQ, process learning and school achievement have been discovered by means of concurrent validation procedures. That is, at a given point in time (during one or more testing sessions, or in conjunction with recently administered achievement tests), an assessment of a child's proficiencies in each of these domains is made. Of greater value to educators are instruments which may be used to diagnose or predict those areas of the school curriculum in which a child is likely to encounter success or failure. "Readiness" tests are generally regarded as indicators of preparedness for instruction in particular curriculum areas. Thus, children who obtain high scores on the "predictor" instrument are expected to produce high scores on the appropriate "criterion" instrument.

Some data on the predictive validity of the PA tasks referred to throughout this paper will now be discussed. For each child in the six populations, information regarding his PA performance and PPVT IQ were collected. One and one-half years after these initial data were obtained, performance scores on a teacher-administered reading achievement test--primary versions of the Stanford Achievement Test (SAT)--were obtained for all samples except the low-SES Black third graders.

It should be mentioned that in longitudinal studies of this kind, subject attrition is of substantial concern. If dropouts are non-random, predictive validity coefficients are likely to be affected, thereby posing a threat to external validity (Campbell & Stanley, 1963). On the other hand, even though systematic losses do occur, one may console himself with the knowledge that: (a) the predictive validity of one's instrument may well be conservative, especially if attrition is primarily localized at the extremes of distribution; and (b) since continuing populations in school are self-selected, it is precisely to such populations that generalizations must be made (assuming that attrition is not a direct result of the initial testing).

Moreover, in the present study the major emphasis is on the comparative validities of the PA and IQ tests in predicting reading achievement. If there is no reason to suspect a differential attrition pattern as related to PA and IQ abilities, then the internal validity of the experiment should be relatively high.

It will be recalled that initially 48 children from each of the populations were tested. The data obtained from the follow-up study and the corresponding sample sizes are presented in Table 5. Predictive

- - - - - - - - - - - - - -

Insert Table 5 about here.

- - - - - - - - - - - - - -

validities based on PPVT IQs and total PA performance are reported, as is the multiple correlation between the PA task, represented by five item-type scores (N, P, NP, SP and NA), and reading achievement.

Two aspects of these validity coefficients deserve special emphasis. The first is that for every sample, substantial predictive power is gained

by entering subjects scores separately for each of the item types rather than relying on the total PA score alone. This result indicates that some item types contribute considerably more to the prediction than others. In this regard, an inspection of the partial correlations in each sample reveals no regularity in the particular item type most responsible for the multiple correlation observed. Surely the study must be replicated on independent samples before assertions are made about the relative importance of specific item types for the populations in question. Nevertheless, the fact that the utility of the PA test appears so much greater when item-types performance is considered separately rather than being summed into a total score encourages the continued development of tasks of the mixed-list variety.

The second noteworthy aspect of Table 5 is that for every sample except the high-SES White third graders, the validity coefficient for the Item Types version of the PA test is higher than that for the PPVT. Again, caution must characterize any interpretation of this result but it is consistent with the notion that a learning task might be a better predictor of long-term school learning than a test of the IQ variety. Additional validation studies using the PA test are currently underway; one of these will permit a comparison of the predictive power of the PA test with that of the Metropolitan test of Reading Readiness with regard to reading achievement at the end of the first-grade year.

In conclusion, we have suggested that assessments of learning proficiency that make provisions for individual and group differences in elaborative production and/or use can substantially increase our understanding of a variety of learning phenomena. It seems apparent that the field of inquiry essayed here is only beginning to be plowed; fortunately, enough of it has cropped to encourage more investment.

References

Ammon, M. S., & Rohwer, W. D., Jr. The training of mnemonic techniques for PA learning in children. Paper presented at the annual meeting of the American Educational Research Association, 1969, Los Angeles.

Anderson, R. H., & Samuels, S. J. Visual recognition memory, paired-associate learning, and reading achievement. Paper presented at the annual meeting of the American Educational Research Association, 1970, Minneapolis.

Bean, J. P., & Rohwer, W. D., Jr. A developmental study of facilitation and interference in children's paired-associate learning. Paper presented at the annual meeting of the American Educational Research Association, 1970, Minneapolis.

Bower, G. H. Mental imagery and associative learning. Paper presented for the Fifth Annual Symposium on Cognition, Carnegie-Mellon University, April, 1969.

Bracht, G. H. The relationship to treatment tasks, personological variables, and dependent variables to aptitude-treatment interactions. Unpublished doctoral dissertation, University of Colorado, Boulder, 1969.

Campbell, D. T., & Stanley, J. C. Experimental and quasi-experimental designs for research. Chicago: Rand McNally, 1963.

Carroll, J. B. A model of school learning. Teachers College Record, 1963, 64, 723-733.

Cronbach, L. J. How can instruction be adapted to individual differences? In R. M. Gagné (Ed.), Learning and individual differences. Columbus, Ohio: Merrill, 1967.

Cronbach, L. J., & Snow, R. E. Individual differences in learning ability as a function of instructional variables. Final report on U. S. Office of Education contract number: OEC-4-6-061269-1217, March, 1969.

Davidson, P. E., & Adams, J. F. Verbal vs. pictorial facilitation of paired-associate learning. Paper presented at the annual meeting of the American Educational Research Association, 1969, Los Angeles.

Ehri, L. C., & Rohwer, W. D., Jr. Verb facilitation of paired-associate learning as a function of syntactic and semantic learning. Journal of Verbal Learning and Verbal Behavior, 1969, 8, 773-781.

Giebink, J. W., & Goodsell, L. L. Reading ability and associative learning for children with a visuomotor deficit. American Educational Research Journal, 1968, 5, 412-420.

Glasman, L. C. A social-class comparison of conceptual processes in children's free recall. Unpublished doctoral dissertation, University of California, Berkeley, 1968.

Green, R. B. SES differences on learning and ability tests in black children. Unpublished master's thesis, University of California, Berkeley, 1969.

Hays, W. L. Statistics for Psychologists. New York: Holt, 1963.

Hotelling, H. Relations between two sets of variates. Biometrika, 1936, 28, 321-377.

Humphreys, L. G., & Dachler, H. P. Jensen's theory of intelligence, Journal of Educational Psychology, 1969, 60, 419-426.

Jensen, A. R. Rote learning in retarded adults and normal children. American Journal of Mental Deficiency, 1965, 69, 828-834.

Jensen, A. R. Varieties of individual differences in learning. In R. M. Gagné (Ed.), Learning and individual differences. Columbus, Ohio: Merrill, 1967.

Jensen, A. R. How much can we boost IQ and scholastic achievement? Harvard Educational Review, 1969, 39, 1-123. (a)

Jensen, A. R. Jensen's theory of intelligence: a reply. Journal of Educational Psychology, 1969, 60, 427-431. (b)

Jensen, A. R., & Rohwer, W. D., Jr. Syntactical mediation of serial and paired associate learning as a function of age. Child Development, 1965, 36, 601-608.

Jensen, A. R., & Rohwer, W. D., Jr. Mental retardation, mental age, and learning rate. Journal of Educational Psychology, 1968, 59, 402-403.

Kee, D. W., & Rohwer, W. D., Jr. Paired-associate learning efficiency as a function of response mode and elaboration. Paper presented at the annual meeting of the American Educational Research Association, 1970, Minneapolis.

Levin, J. R., & Rohwer, W. D., Jr. Verbal organization and the facilitation of serial learning. Journal of Educational Psychology, 1968, 59, 186-190.

Levin, J. R., & Rohwer, W. D., Jr. Individual differences in the learning of verbally and pictorially presented paired associates. American Educational Research Journal, in press.

Marascuilo, L. A. Large-sample multiple comparisons. Psychological Bulletin, 1966, 65, 280-290.

Martin, C. J. Associative learning strategies employed by deaf, blind, retarded and normal children. Educational Research Series, 1967, 38, 1-158.

Meredith, W. Canonical correlations with fallible data. Psychometrika, 1964, 29, 55-65.

Montague, W. E., Adams, J. A., & Kiess, H. O. Forgetting and natural language mediation. Journal of Experimental Psychology, 1966, 72, 829-833.

Montague, W. D., & Wearing, A. J. The complexity of natural language mediators and its relation to paired-associate learning. Psychonomic Science, 1967, 7, 135-136.

Otto, W. The acquisition and retention of paired associates by good, average, and poor readers. Journal of Educational Psychology, 1961, 52, 241-248.

Porebski, O. R. Discriminatory and canonical analysis of technical college data. British Journal of Mathematical and Statistical Psychology, 1966, 19, 215-236.

Rohwer, W. D., Jr. Constraint, syntax, and meaning in paired-associate learning. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 541-547.

Rohwer, W. D., Jr. Social class differences in the role of linguistic structures in paired-associate learning: Elaboration and learning proficiency. Final report on U. S. Office of Education Basic Research Project number: 5-0605, Contract number: OE 6-10-273. November, 1967.

Rohwer, W. D., Jr. Mental elaboration and proficient learning. Minnesota Symposia on Child Psychology, in press.

Rohwer, W. D., Jr., & Ammon, M. S. Locus of facilitation in noun-pair learning. Paper presented at the annual meeting of the Western Psychological Association, 1968, San Diego, California.

Rohwer, W. D., Jr., Ammon, M. S., Suzuki, N., & Levin, J. R. Populations differences in learning proficiency. Journal of Educational Psychology, in press.

Rohwer, W. D., Jr., & Levin, J. R. Action, meaning and stimulus selection in paired-associate learning. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 137-141.

Rohwer, W. D., Jr., & Lynch, S. Semantic constraint in paired-associate learning. Journal of Educational Psychology, 1966, 57, 271-278.

Rohwer, W. D., Jr., & Lynch, S. Retardation, school strata and learning proficiency. American Journal of Mental Deficiency, 1968, 73, 91-96.

Rohwer, W. D., Jr., Lynch, S., Levin, J. R., & Suzuki, N. Grade level, school strata, and learning efficiency. Journal of Educational Psychology, 1968, 59, 26-31.

Rohwer, W. D., Jr., Lynch, S., Suzuki, N., & Levin, J. R. Verbal and pictorial facilitation of paired-associate learning. Journal of Experimental Child Psychology, 1967, 5, 294-302.

Runquist, W. N., & Farley, F. H. The use of mediators in the learning of verbal paired associates. Journal of Verbal Learning and Verbal Behavior, 1964, 3, 280-285.

Semler, I. J., & Iscoe, I. Comparative and developmental study of the learning abilities of Negro and white children under four conditions. Journal of Educational Psychology, 1963, 54, 38-54.

Stevenson, H. W., Hale, G. A., Klein, R. E., & Miller, L. K. Interrelations and correlates in children's learning and problem solving. Monograph of the Society for Research in Child Development, 1968, 33 (No. 7).

Suzuki, N., & Rohwer, W. D., Jr. Deep structure in the noun-pair learning of children and adults. Child Development, 1969, 40, 911-919.

Walberg, H. J. A model for research on instruction. School Review, 1970, 78, 185-200.

Winer, B. J. Statistical principles in experimental design. New York: McGraw-Hill, 1962.

Zeaman, D., & House, B. J. The relation of IQ and learning. In R. M. Gagné (Ed.), Learning and individual differences. Columbus, Ohio: Merrill, 1967.

Footnote

[1] The preparation of this paper was facilitated by the Institute of Human Learning, University of California, Berkeley, which is supported by grants from the National Institutes of Health, and the Wisconsin Research and Development Center for Cognitive Learning, University of Wisconsin, Madison.

Table 1

Correlation Coefficients between PPVT IQ and PA Test Performance as a Function of Grades and Item Types in High-SES White Samples

Grades	Item Types				
	Nouns (N)	Pictures (P)	Nouns-Pictures (NP)	Sentences-Pictures (SP)	Nouns-Action (NA)
K (N=48)	.15	.13	.27*	.40**	.42**
1 (N=48)	.00	.31*	.08	.40**	.14
3 (N=48)	.18	.14	-.03	.27*	.09

* $p < .05$

** $p < .01$

Table 2

Reliability Estimates of the Paired-Associate Learning Task for Six Populations*

Population	Reliability
Kindergarten:	
High-SES White	.54
Low-SES Black	.87
1st Grade:	
High-SES White	.80
Low-SES Black	.67
3rd Grade:	
High-SES White	.74
Low-SES Black	.77

* Taken from Rohwer, Ammon, Suzuki and Levin, in press.

Table 3

Significant Canonical Correlations between Two Forms of the PA Task for Six Populations

Population	Canonical Correlation	
	I	II
Kindergarten:		
High-SES White	.63	---
Low-SES Black	.92	.66
1st Grade:		
High-SES White	.84	---
Low-SES Black	.76	.59
3rd Grade:		
High-SES White	.76	---
Low-SES Black	.83	.68

Table 4

Canonical Structure of the PA Task: Correlations Between Canonical Variates and Respective Original Variables

	High-SES Whites		Low-SES Blacks			
Canonical Variate	I		I		II	
	Form A	Form B	Form A	Form B	Form A	Form B
Kindergarten:						
N	.10	.12	-.63	-.61	.38	.66
P	.18	.49	-.62	-.72	-.65	-.23
NP	.62	.56	-.88	-.68	.12	.21
SP	.58	.92	-.89	-.79	.13	.12
NA	.88	.51	-.90	-.98	.16	-.05
1st Grade:						
N	-.42	-.36	-.55	-.30	.38	.60
P	-.68	-.75	-.67	-.78	-.52	-.26
NP	-.80	-.72	-.63	-.76	.14	.22
SP	-.61	-.62	-.50	-.79	.42	.28
NA	-.87	-.84	-.78	-.53	.24	.73
3rd Grade:						
N	-.67	-.78	-.42	-.65	-.80	-.71
P	-.81	-.74	-.68	-.81	.54	.25
NP	-.77	-.88	-.91	-.80	-.22	.26
SP	-.66	-.67	-.47	-.64	.15	.12
NA	-.64	-.48	-.64	-.74	-.19	-.03

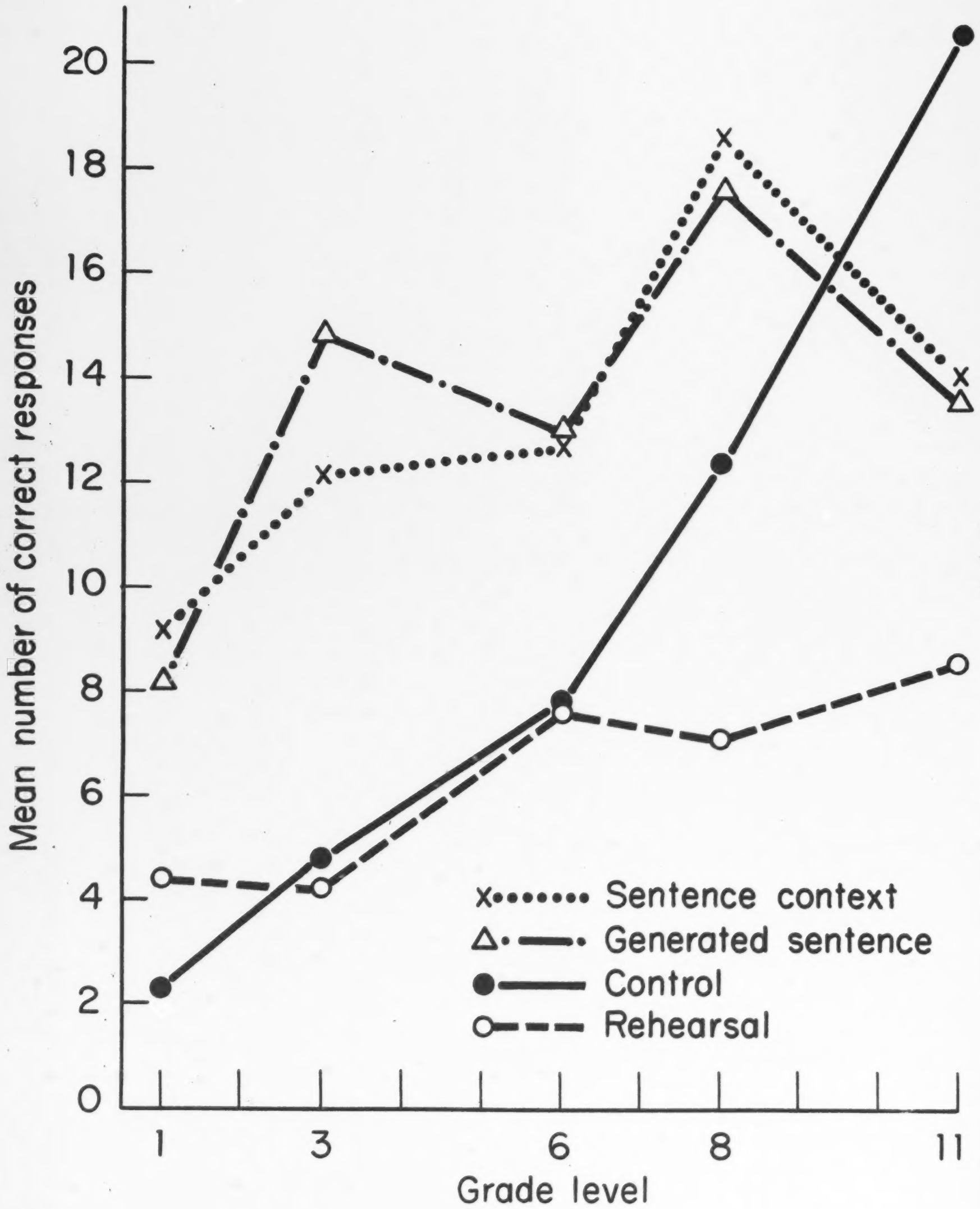
Table 5

Correlation between IQ and Reading Achievement, and between PA Performance and Reading Achievement, as a Function of Populations

Population		PPVT IQ	PA Total	PA Item Types
	n	r	r	R
Kindergarten:				
High-SES White	32	.41	.40	.74
Low-SES Black	26	.33	.18	.58
1st Grade:				
High-SES White	43	.35	.07	.50
Low-SES Black	38	.30	.13	.32
3rd Grade:				
High-SES White	36	.64	-.10	.35
Low-SES Black		---	---	---

Figure Caption

Figure 1. Mean number of correct responses on Trial 1 as a function of PA learning conditions and grade level.


Mean number of correct responses
20
18
16
14
12
10
8
6
4
2
0
1
3
6
8
11
Grade level
Sentence context
Generated sentence
Control
Rehearsal